DDF annual report

Title of Investigation:

Web-enabled Intelligent Tutoring System (WITS)

Principal Investigator:

Walt Truszkowski (Code 588)

Other External Collaborators: Southeastern University (SEU):

Dr. Abe Eftekhari (Co-PI), Wai Foong, and Daniel Hartanto; Worcester Polytechnic Institute (WPI): Dr. Dave Brown, Marc DiNino, James Kazmierczak, and Maryanne Plunkett

Initiation Year:

FY 2005

Aggregate Amount of Funding Authorized in FY 2005 and Earlier Years:

$20,000

Funding Authorized for FY 2005:

$20,000

Actual or Expected Expenditure of FY 2005 Funding:

$20,000

Status of Investigation at End of FY 2005:

Not completed

Expected Completion Date:

October 2006 (depending on funding extension)

Purpose of Investigation:

Government agencies, universities, colleges, high schools, and other organizations are currently using online courses to educate users and distribute information. The interactive part of most online courses, however, does not always include intelligent decision-making features. The Web-enabled Intelligent Tutoring System (WITS) project addresses this deficiency with the development of an innovative Web-based training system. It introduces an embedded "Artificial Intelligence" (AI) module into the system that makes online learning and tutoring more interactive and adaptive to student needs and capabilities.

Accomplishments to Date (SEU):

WITS consists of several modules: Knowledge Base, Curriculum Manager, Tutor, Student Model, and the AI Module. The Incremental Model is the software development process used to build each of the system's modules. The Incremental Model uses the iterative prototyping method, where basic requirements are addressed first and supplementary features are added later.

To date, a prototype of Knowledge Base database structure has been created to store the various data elements used in WITS. Currently, the Knowledge Base enables test questions, answer choices, and images to be referenced, so that the AI module can retrieve these data elements.

The current knowledge domain for the Knowledge Base is Data Communications, with a section devoted to Satellite Communications. However, WITS is designed to be able to capture other knowledge domains.

The Curriculum Manager contains the mapping structure of course materials (e.g., lecture notes, slides, questions, and images). This mapping structure allows the instructor/course developer to organize the course materials to be displayed on the student's browser. Hence, sets of questions (contained in the Knowledge base) can be mapped to each lecture session of the course. In addition, this mapping structure allows the AI module to strategically adapt the learning materials according to an assessment of the student's progress. The WITS project team has created a prototype of such a Curriculum Manager. The current version of the Curriculum Manager enables the instructor/course developer to input questions as well as the correct answers and related images to create a mapping structure. Validation features such as valid number of answer choices in the pool have been included.

The Tutor module determines the interface layout, which will in turn determine what the browser layout will look like. Currently, there are two layouts (see Figure 1 and Figure 2) defined for test questions. The defined layout provides a structure for containing the data elements (e.g., question, answer choice pool, correct answer(s), and hints) of the test question. Different layouts are used to facilitate alternative forms of test question methods (e.g., true/false, multiple choice, matching images, and interactive manipulations [see Figure 3]). These layouts are based on the concept of inquiry-based teaching and learning activities. Given the student's answer selection, the Tutor module communicates with the AI module to retrieve the next action. The AI module diagnoses and adapts the teaching/learning materials accordingly.

Currently, the WITS team is learning more about inquiry-based teaching and learning activities

so that it can apply the concepts in an online environment through the use of various test question layouts.

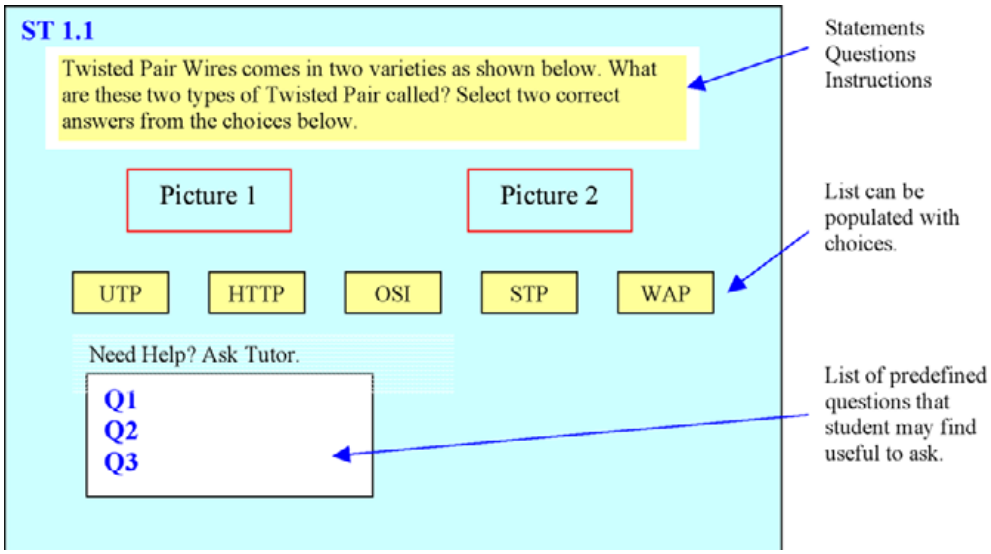

Figure 1. Layout 1 for test question

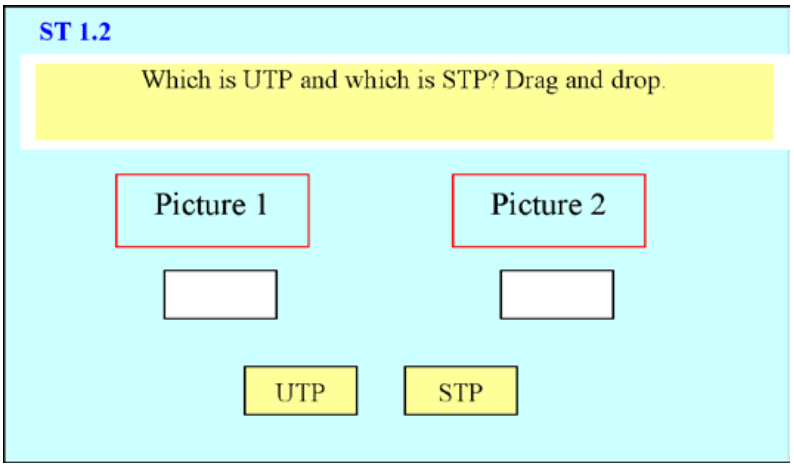

Figure 2. Layout 2 for test question

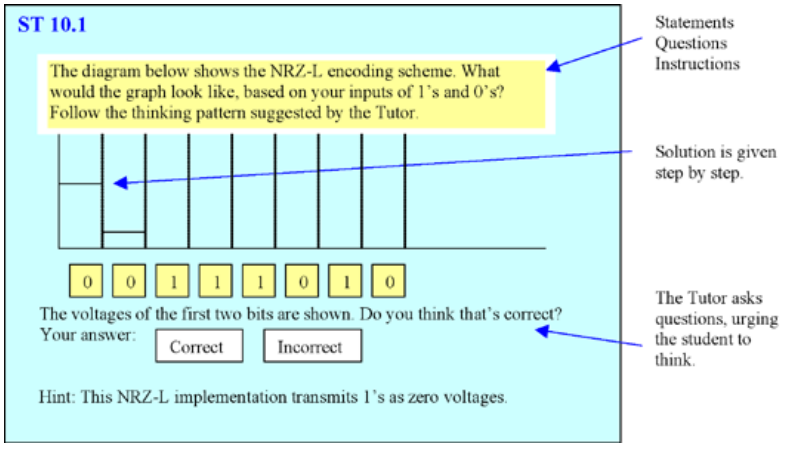

Figure 3. Interactive manipulations layout

The Student Model stores and categorizes the student's session. Data stored include user profile and mastery level of topic contents. This component of WITS will record the student's progress and learning styles. Currently, the WITS team is working on predefined categories and quantifiable metrics to be used for assessing the student's progress and learning styles.

The AI module directs teaching strategies based on updates from the Tutor with regard to the student's actions. Given certain student actions and responses to test questions, as well as information from the Student Model, the AI module can intelligently select the possible set of subsequent test questions or hint(s) based on the Curriculum Manager's mapping structure.

Accomplishments to Date (WPI):

The WITS team has benefited greatly from its collaboration with Worcester Polytechnic Institute (WPI). The WPI team is made up of Marc DiNino, James Kazmierczak, and Maryanne Plunkett, with guidance from Dr. David C. Brown.

Basing ist work on the architectural design provided by Southeastern University (SEU), WPI created the first prototype of the AI module. WPI defined the XML Mapping Structure, which is used to describe the order in which the data elements (e.g., Test Sets, Tests, Questions, Hints, and Help) may occur during a WITS session. WPI also created an XML parser package that contains all of the classes that are used to parse the XML documents.

Planned Future Work:

The WITS team has not yet integrated the total system. The passing of control messages between the various modules is currently being scrutinized.

Future work includes enabling the Student Model to store the student's psychological model (used to evaluate the student's learning style). This forms the first part of the non-intrusive Assessment Capability that WITS hopes to have.

The AI module is designed to possess the ability to analyze the student's solution, diagnose the student's working methods and psychological model, and suggest optimal paths for learning. Future work would include enabling the AI module to prompt the instructor/course developer to modify certain mapping structures in the Curriculum Manager so that the system can be tweaked to perform better. Optimal path analysis and diagnostics form the second part of the non-intrusive assessment capability that WITS hopes to have.

Key Points Summary:

Project's innovative features: WITS will enable effective, intelligence-based, learning via the Internet. Learning is interactive, progressive, rapid, and easy. Furthermore, the self-paced provision and non-intrusive assessment capability, provided by WITS, make the course usable for students at different levels.

Potential payoff to Goddard/NASA: The major innovations introduced by WITS will be the AI module, the ability to adapt to differing pedagogical styles, and the development of a course of training that will be of interest not only to students but also to seasoned participants in satellite-communications techniques. The potential use of WITS to support control-center personnel

training will be a major payoff.

The criteria for success: The criterion for success will be the incorporation of WITS into the curriculum at Southeastern University.

Technical risk: Anticipated challenges include finding optimal algorithms and heuristics or rules of thumb and guides to expand the AI module's capability. In addition, performance and load testing is another concern, especially when the AI module serves multiple users simultaneously in a real-time environment. Other risks include the ability to characterize pedagogical techniques to make them usable by the AI module and the allotted timeframe to get an operational WITS prototype in place.